

semiconductor chip, a chipset, or a (hardware) module comprising such chip or chipset; this, however, does not exclude the possibility that a functionality of an apparatus or module, instead of being hardware implemented, be implemented as software in a (software) module such as a computer program or a computer program product comprising executable software code portions for execution/being run on a processor;

**[0087]** a device may be regarded as an apparatus or as an assembly of more than one apparatus, whether functionally in cooperation with each other or functionally independently of each other but in a same device housing, for example.

**[0088]** In general, it is to be noted that respective functional blocks or elements according to above-described aspects can be implemented by any known means, either in hardware and/or software, respectively, if it is only adapted to perform the described functions of the respective parts. The mentioned method steps can be realized in individual functional blocks or by individual devices, or one or more of the method steps can be realized in a single functional block or by a single device.

**[0089]** Generally, any method step is suitable to be implemented as software or by hardware without changing the idea of the present invention. Devices and means can be implemented as individual devices, but this does not exclude that they are implemented in a distributed fashion throughout the system, as long as the functionality of the device is preserved. Such and similar principles are to be considered as known to a skilled person.

**[0090]** Software in the sense of the present description comprises software code as such comprising code means or portions or a computer program or a computer program product for performing the respective functions, as well as software (or a computer program or a computer program product) embodied on a tangible medium such as a computer-readable (storage) medium having stored thereon a respective data structure or code means/portions or embodied in a signal or in a chip, potentially during processing thereof.

**[0091]** The present invention also covers any conceivable combination of method steps and operations described above, and any conceivable combination of nodes, apparatuses, modules or elements described above, as long as the above-described concepts of methodology and structural arrangement are applicable.

**[0092]** In view of the above, there are provided measures for ACK/NAK bit bundling in carrier aggregation scenarios. Such measures exemplarily comprise generating a set of acknowledgement bits confirming receipt of payload data of a radio frame in a carrier aggregation mode aggregating a primary and at least one secondary carrier, said radio frame being divided into a plurality of downlink subframes and uplink subframes, each of said downlink subframes comprising at least one codeword per carrier, each of said acknowledgement bits is allocated to one of said codewords of one of said downlink subframes, and applying spatial domain bundling and/or time domain bundling on said set of acknowledgement bits distinctive for each of said primary and said at least one secondary carrier, wherein said spatial domain bundling is an AND operation of all acknowledgement bits allocated to each codeword of one carrier of said primary and said at least one secondary carrier and one downlink subframe of said plurality of downlink subframes of said radio frame, and said time domain bundling is an AND operation of all

acknowledgement bits associated with corresponding downlink subframes of said radio frame.

**[0093]** Even though the invention is described above with reference to the examples according to the accompanying drawings, it is to be understood that the invention is not restricted thereto. Rather, it is apparent to those skilled in the art that the present invention can be modified in many ways without departing from the scope of the inventive idea as disclosed herein.

#### LIST OF ACRONYMS AND ABBREVIATIONS

3GPP Third Generation Partnership Project

**[0094]** ACK/NAK acknowledgement/negative acknowledgement, A/N

CC component carrier

DL downlink

eNB evolved NodeB

HARQ hybrid automatic repeat request

LTE Long Term Evolution

**[0095]** PCell primary cell

PUCCH physical uplink control channel

SCell secondary cell

TDD time division duplex

UE user equipment

UL uplink

#### 1. A method comprising:

generating a set of acknowledgement bits confirming receipt of payload data of a radio frame in a carrier aggregation mode aggregating a primary and at least one secondary carrier, said radio frame being divided into a plurality of downlink subframes and uplink subframes, each of said downlink subframes comprising at least one codeword per carrier, each of said acknowledgement bits is allocated to one of said codewords of one of said downlink subframes; and

applying spatial domain bundling and/or time domain bundling on said set of acknowledgement bits distinctive for each of said primary and said at least one secondary carrier; wherein

said spatial domain bundling is an AND operation of all acknowledgement bits allocated to each codeword of one carrier of said primary and said at least one secondary carrier and one downlink subframe of said plurality of downlink subframes of said radio frame; and

said time domain bundling is an AND operation of all acknowledgement bits associated with corresponding downlink subframes of said radio frame.

#### 2. The method according to claim 1, wherein

in relation to said applying, said method further comprises performing, for said primary carrier, said spatial domain bundling for each downlink subframe of said plurality of downlink subframes of said radio frame;

performing, for each of said at least one secondary carrier, said spatial domain bundling for each downlink subframe of said plurality of downlink subframes of said radio frame; and

performing, for each of said at least one secondary carrier, said time domain bundling for each spatial domain bundled acknowledgement bit associated with corresponding downlink subframes of said radio frame.